Claims

1. A parity check matrix generation method for generating parity check matrix H of m rows and n columns in low-density parity-check code; wherein:

said parity check matrix H is made up from partial matrix H1 of m rows and k columns (where k = n–m) and partial matrix H2 of m rows and m columns; and

positions of matrix elements "1" of each row of said partial matrix H1 are determined to satisfy conditions that, when any two rows contained in said partial matrix H1 are selected, periods of the two rows are relatively prime, or when the periods of the two rows are identical, phases are different.

2. The parity check matrix generation method according to claim 1, wherein:

period list P={p(1), p(2), ..., p(PL)} (where p(1)–p(PL) are relatively prime) is determined; and

for each of elements p(j) of said period list P, a maximum p(j) rows of partial matrix H1 are generated in which the periods are p(j) and the phases are different.

3. The parity check matrix generation method according to claim 2, wherein elements from element p(2) to element p(PL) are generated based on leading element p(1).

4. The parity check matrix generation method according to claim 3, wherein elements p(j) of period list P are generated such that elements

p(j) are the smallest values among values that satisfy a condition of being relatively prime with all preceding elements from element p(1) to element p(j−1).

5. The parity check matrix generation method according to claim 3, wherein elements p(j) of period list P are generated such that elements p(j) are the smallest values among values that each satisfy a condition of being a prime number greater than preceding element p(j−1).

6. The parity check matrix generation method according to any one of claims 1 to 5, wherein a unit matrix is generated as partial matrix H2.

7. The parity check matrix generation method according to claim 1, wherein a lower triangular matrix is generated as partial matrix H2 by determining the positions of matrix elements "1" within a lower triangle matrix such that the conditions are satisfied that, when any two rows contained within partial matrix H2 are selected, the periods of the two rows are relatively prime, or when the periods of the two rows are identical, their phases are different.

8. The parity check matrix generation method according to claim 7, wherein:

period list P={p(1), p(2), ..., p(PL)} (where p(1)–p(PL) are relatively prime) is determined; and

for each of elements p(j) of said period list P, a maximum p(j) rows of partial matrix H2 are generated in which the periods are p(j) and the phases are

different.

9. The parity check matrix generation method according to claim 8, wherein elements from element p(2) to element p(PL) are generated based on leading element p(1).

10. The parity check matrix generation method according to claim 9, wherein elements p(j) of period list P are generated such that elements p(j) are the smallest values among values that satisfy a condition of being relatively prime with all preceding elements from element p(1) to element p(j–1).

11. The parity check matrix generation method according to claim 9, wherein elements p(j) of period list P are generated such that elements p(j) are the smallest values among values that each satisfy a condition of being a prime number greater than preceding element p(j–1).

12. A parity check matrix generation method for generating a parity check matrix of m rows and n columns in a low-density parity-check code, wherein:

row r of a parity check matrix is generated by using period list P={p(1), p(2), ..., p(PL)} (where p(1)–p(PL) are relatively prime) to: set as "1" matrix elements that correspond to columns c that satisfy conditions, using integer i and prescribed value F(j), $1 \le c \le n-m$ and $c=p(j)\bullet i+r+F(j)$ if $N(j-1)+1 \le r \le N(j)$, where N(j) is defined as a sum of values from element p(1) to element p(j) of said period list P, and moreover, N(0) is defined as "0"; to set as "1"

matrix elements that correspond to columns c that satisfy a condition c=n–m+r; and to set as "0" matrix elements that do not satisfy any of said conditions.

13. The parity check matrix generation method according to claim 12, wherein F(j) = –N(j–1).

14. The parity check matrix generation method according to claim 12, wherein F(j) = n–m.

15. A parity check matrix generation method for generating a parity check matrix of m rows and n columns in low-density parity-check codes; wherein:

row r of a parity check matrix is generated by using period list P={p(1), p(2), ..., p(PL)} (where p(1)–p(PL) are relatively prime) to: set as "1" matrix elements that correspond to columns c that satisfy conditions, using integer i, $1 \le c \le n-m+r$ and $c=p(j)\bullet i+n-m+r$ if $N(j-1)+1 \le r \le N(j)$, where N(j) is defined as a sum of values from element p(1) to element p(j) of said period list P, and moreover, N(0) is defined as "0"; and to set as "0" matrix elements that do not satisfy any of said conditions.

16. A parity check matrix generation method for generating a parity check matrix of m rows and n columns in low-density parity-check codes; wherein:

row r of a parity check matrix is generated by using period list P= {p(1), p(2), ..., p(PL)} (where p(1)–p(PL) are relatively prime) and period list Q={q(1),

q(2), ..., q(QL)} (where q(1)–q(QL) are relatively prime) to: set as "1" matrix elements that correspond to columns c that satisfy conditions, using integer i and a prescribed value F(j), $1 \leq c \leq n-m$ and $c=p(j) \bullet i+r+F(j)$ if $N(j-1)+1 \leq r \leq N(j)$, where N(j) is defined as a sum of values from element p(1) to element p(j) of said period list P, and moreover, N(0) is defined as "0"; to set as "1" matrix elements that correspond to columns c that satisfy conditions, using integer i, $n-m+1 \leq c \leq n-m+r$ and $c=q(j) \bullet i+n-m+r$ if $M(j-1)+1 \leq r \leq M(j)$, where M(j) is defined as a sum of values from element q(1) to element q(j) of period list Q, and moreover, M(0) is defined as "0"; and to set as "0" matrix elements that do not satisfy any of said conditions.

17. The parity check matrix generation method according to claim 16, wherein $F(j) = -N(j-1)$.

18. The parity check matrix generation method according to claim 16, wherein $F(j) = n-m$.

19. The parity check matrix generation method according to claim 12, claim 15 or claim 16, wherein period list P is determined by generating elements from element p(2) to element p(PL) based on leading element p(1).

20. The parity check matrix generation method according to claim 19, wherein elements p(j) of period list P are generated such that elements p(j) are the smallest values among values that satisfy a condition of being relatively prime with all preceding elements from element p(1) to element p(j–1).

21. The parity check matrix generation method according to claim 19, wherein elements p(j) of period list P are generated such that elements p(j) are the smallest values among values that each satisfy a condition of being a prime number greater than preceding element p(j–1).

22. A data transmission system that includes: an encoding device for encoding data and a decoding device for decoding data that have been encoded; wherein:

said encoding device, based on prescribed parameters, uses the parity check matrix generation method described in any one of claim 1, claim 12, claim 15, and claim 16 to generate a parity check matrix, uses the generated parity check matrix to perform low-density parity encoding to convert data to codewords, and transmits the converted codewords to said decoding device by way of a transmission line; and

said decoding device, based on parameters identical to the parameters used by said encoding device, uses said parity check matrix generation method to generate a parity check matrix, and uses the generated parity check matrix to decode codewords that have been received from said encoding device to convert to the data that preceded encoding.

23. The data transmission system according to claim 22, wherein the

encoding device generates a parity check matrix based on a prescribed period list P as the parameters; and

the decoding device generates a parity check matrix based on a period list P

identical to period list P used by said encoding device.

24. The data transmission system according to claim 22, wherein: the encoding device: determines period list P by generating elements from element p(2) to element p(PL) based on leading element p(1) of period list P as the parameters; and generates a parity check matrix based on the determined period list; and the decoding device: determines period list P by generating elements from element p(2) to element p(PL) based on element p(1) that is identical to element p(1) used by said encoding device; and generates a parity check matrix based on the determined period list.

25. The data transmission system according to claim 24, wherein: the encoding device generates elements p(j) of period list P such that elements p(j) are the smallest values of values that satisfy a condition of being relatively prime with all preceding elements from element p(1) to element p(j−1); and the decoding device generates elements p(j) of period list P such that elements p(j) are the smallest values of values that satisfy the condition of being relatively prime with all preceding elements from element p(1) to element p(j−1).

26. The data transmission system according to claim 24, wherein: the encoding device generates elements p(j) of period list P such that

elements p(j) are the smallest values of values that each satisfy a condition of being a prime number greater than preceding element p(j–1); and the decoding device generates elements p(j) of period list P such that elements p(j) are the smallest values of values that each satisfy the condition of being a prime number greater than the preceding element p(j–1).

27. The data transmission system according to claim 22, wherein: the encoding device transmits parameters to the decoding device by way of a transmission line; and said decoding device uses parameters received from said encoding device to generate a parity check matrix based on parameters identical to the parameters used by said encoding device.

28. The data transmission system according to claim 22, wherein: the decoding device transmits parameters to the encoding device by way of a transmission line; and said encoding device uses parameters received from said decoding device to generate a parity check matrix based on parameters identical to parameters used by said decoding device.

29. The data transmission system according to claim 22, wherein: the encoding device transmits parameters for each of prescribed time intervals to the decoding device by way of a transmission line; and said decoding device uses parameters received from said encoding device to thus generate a parity check matrix based on parameters identical to parameters used by said encoding device.

30. The data transmission system according to claim 22, wherein: the decoding device transmits parameters for each of prescribed time intervals to the encoding device by way of a transmission line; and said encoding device uses parameters received from said decoding device to generate a parity check matrix based on parameters identical to parameters used by said decoding device.

31. The data transmission system according to claim 22, wherein: the encoding device transmits parameters to the decoding device by way of a transmission line when a content of said parameters has been updated; and said decoding device uses parameters received from said encoding device to generate a parity check matrix based on parameters identical to parameters used by said encoding device.

32. The data transmission system according to claim 22, wherein: the decoding device transmits parameters to the encoding device by way of a transmission line when a content of said parameters has been updated; and said encoding device uses parameters received from said decoding device to generate a parity check matrix based on parameters identical to parameters used by said decoding device.

33. An encoding device for: based on prescribed parameters, using the parity check matrix generation method according to any one of claim 1,

claim 12, claim 15, and claim 16 to generate a parity check matrix; and using the generated parity check matrix to perform low-density parity encoding to convert data to codewords, and transmitting the converted codewords to a decoding device by way of a transmission line.

34. A decoding device for: receiving codewords from an encoding device by way of a transmission line; and based on prescribed parameters, using the parity check matrix generation method according to any one of claim 1, claim 12, claim 15, and claim 16 to generate a parity check matrix, and using the generated parity check matrix to decode said received codewords and convert to data that preceded encoding.

35. A parity check matrix generation program for generating parity check matrix H of m rows and n columns in low-density parity-check code, said parity check matrix generation program causing a computer to execute processes of:

constructing said parity check matrix H from partial matrix H1 of m rows and k columns and partial matrix H2 of m rows and m columns (where m = n–k); and

determining positions of matrix elements "1" of each row of said partial matrix H1 to satisfy conditions that, when any two rows contained in said partial matrix H1 are selected, periods of the two rows are relatively prime, or when the periods of the two rows are identical, phases are different.

36. A parity check matrix generation program for generating a parity check matrix of m rows and n columns in low-density parity-check

code, said parity check matrix generation program causing a computer to execute processes of:

generating row r of a parity check matrix by using period list P={p(1), p(2), ..., p(PL)} (where p(1)–p(PL) are relatively prime) to: set as "1" matrix elements that correspond to columns c that satisfy conditions, using integer i and a prescribed value F(j), 1 ≤ c ≤ n–m and c=p(j)•i+r+F(j) if N(j–1)+1 ≤ r ≤ N(j), where N(j) is defined to be a sum of values from element p(1) to element p(j) of said period list P, and moreover, N(0) is defined to be "0"; to set as "1" matrix elements that correspond to columns c that satisfy a condition c=n–m+r; and to set as "0" matrix elements that do not satisfy any of said conditions.

37. A parity check matrix generation program for generating a parity check matrix of m rows and n columns in low-density parity-check code, said parity check matrix generation program causing a computer to execute processes of:

generating row r of a parity check matrix by using period list P={p(1), p(2), ..., p(PL)} (where p(1)–p(PL) are relatively prime) to: set as "1" matrix elements that correspond to columns c that satisfy conditions, using integer i, 1 ≤ c ≤ n–m+r and c=p(j)•i+n–m+r if N(j–1)+1 ≤ r ≤ N(j), where N(j) is defined to be a sum of values from element p(1) to element p(j) of said period list P, and moreover, where N(0) is defined to be "0"; and to set as "0" matrix elements that do not satisfy any of said conditions.

38. A parity check matrix generation program for generating a parity check matrix of m rows and n columns in low-density parity-check

code, said parity check matrix generation program causing a computer to execute a process of:

generating row r of a parity check matrix by using period list P={p(1), p(2), ..., p(PL)} (where p(1)–p(PL) are relatively prime) and period list Q={q(1), q(2), ..., q(QL)} (where q(1)–q(QL) are relatively prime) to: set as "1" matrix elements that correspond to columns c that satisfy conditions, using integer i and a prescribed value F(j), $1 \le c \le n-m$ and $c=p(j) \bullet i+r+F(j)$ if $N(j-1)+1 \le r \le N(j)$, where N(j) is defined as a sum of values from element p(1) to element p(j) of said period list P, and moreover, N(0) is defined as "0"; to set as "1" matrix elements that correspond to columns c that satisfy conditions, using integer i, $n-m+1 \le c \le n-m+r$ and $c=q(j) \bullet i+n-m+r$ if $M(j-1)+1 \le r \le M(j)$, where M(j) is defined as a sum of values from element q(1) to element q(j) of said period list Q, and moreover, M(0) is defined as "0"; and to set as "0" matrix elements that do not satisfy any of said conditions.